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Discovery of Ichthyosaur Remains (Reptilia) in the Upper Cenomanian of Bavaria

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With 2 figures in the text and 1 plate

Abstract

For the first time ichthyosaur remains from the Upper Cenomanian Regensburger Grünsandstein of Bavaria are recorded and assigned to *Platypterygius* sp.. It is the stratigraphically latest ichthyosaur known in the fossil record. During the Cretaceous ichthyosaurs become rare, and their extinction probably came about during the Cenomanian-Turonian transition.

Kurzfassung

Es werden erstmals aus dem Regensburger Grünsandstein (Obercenoman) von Saal a. d. Donau (Niederbayern) Fossilreste eines Ichthyosauriers bekannt gemacht und als *Platypterygius* sp. beschrieben. Es handelt sich um die stratigraphisch jüngsten Ichthyosaurierfunde, die bisher bekannt sind. Während der Kreide werden Ichthyosaurier selten und ihr Aussterben erfolgte wahrscheinlich an der Cenoman/Turon-Grenze.

Résumé

Des restes d'ichthyosaures trouvés dans le Cénomanien supérieur (Regensburger Grünsandstein) de Bavière sont décrits pour la première fois et rapprochés de *Platypterygius* sp.. Il s'agit des restes d'ichthyosaures les plus récents trouvés à ce jour. Durant le Crétacé, les ichthyosaures deviennent rares et leur extinction se situe probablement durant la transition Cénomanien-Turonien.

Introduction

Ichthyosaurs are a group of Mesozoic reptiles with very pronounced adaptations to marine life. They are known as early as the Smithian (late Lower Triassic) (Cox & Smith, 1973; Callway & Brinkman, 1989) up to the Cenomanian (base of Upper Cretaceous) (Baird, 1984;

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BARDET, 1992). During the Triassic, ichthyosaurs are represented by mainly coastal forms but since the end of this period and during Jurassic and Cretaceous times, they are known by only pelagic forms.

Contrary to the Triassic and Jurassic members of the order which were greatly diversified, the ichthyosaurs become scarce during the Cretaceous and are only represented by the cosmopolitan genus *Platypterygius* v. HUENE (MCGOWAN, 1972). In the Albian and Cenomanian, four species are currently recognized: in North America, *P. americanus* ranging from the Upper Albian to the Lower Cenomanian (NACE, 1939, 1941; MCGOWAN, 1972); in Australia, *P. longmanni* reported from up to the Upper Albian (WADE, 1990); in Russia, *P. kiprijanoffi* known from Upper Albian and Cenomanian deposits (NESSOV et al., 1988); and finally, in Western Europe, *P. campylodon* to which most of the specimens commonly have been assigned. It should be noted, however, that this species is only poorly defined (MCGOWAN, 1972), and has been based on material which is not diagnostic (BARDET, 1990). On the other hand, new material recently found could be used to define the species more adequately (BARDET, in prep.). The specimens from Western Europe known to date range from the Albian to possibly the Middle Cenomanian and have represented the youngest occurrence of ichthyosaurs in the fossil record (BARDET, 1992).

This report of ichthyosaur remains from the Upper Cenomanian of Bavaria is thus of particular interest, because it is evidence of the most recent and accurately identified ichthyosaur currently known.

Locality and Stratigraphy

The material, probably all part of a single individual, has been discovered in the eastern part of the large limestone quarry of the Süddeutsche Kalkstickstoff-Werke (SKW quarry) near Saal a.d. Donau, about 4 km southeast of Kelheim (Niederbayern) (fig. 1). The ichthyosaur remains were recovered from the upper part of the Regensburger Grünsandstein, a glauconitic block sandstone discordantly overlying the Upper Jurassic Kelheimer Kalke and the Lower Cretaceous

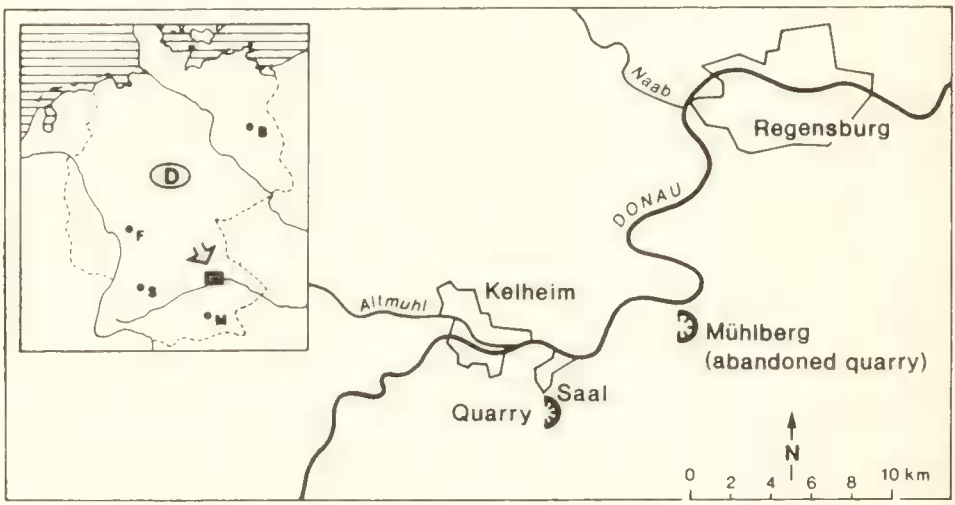

Fig. 1: Location map of the SKW quarry at Saal a. d. Donau with transgressive Upper Cenomanian Grünsandstein and Mühlberg quarry with transgressive culmination during Early Turonian.

(? Valanginian) Schutzfels-Schichten. The Regensburger Grünsandstein is covered by the Eibrunner Mergel (latest Cenomanian to early Turonian) as exposed in the abandoned quarry of Mühlberg, 7,5 km NE of Saal a. d. D. near Bad Abbach (fig. 2).

The age of the Regensburger Grünsandstein is Upper Cenomanian, according to WEISS (1982) and STEIGER et al. (1985), equivalent to the *Rotalipora cushmani-greenhornensis* zone of the planctonic foraminifera zonation scheme. Recently, a detailed analysis of the Cretaceous series exposed in the quarry at Saal was published by HERM & HÖFLING (1994). According to these authors the so-called Quadersandstein facies from which the ichthyosaur remains originate has been deposited as a glauconitic sandstone with cross-bedded layers of pectinid and inoceramid shill at the base and intercalated siliceous sponge biostromes and lithistid

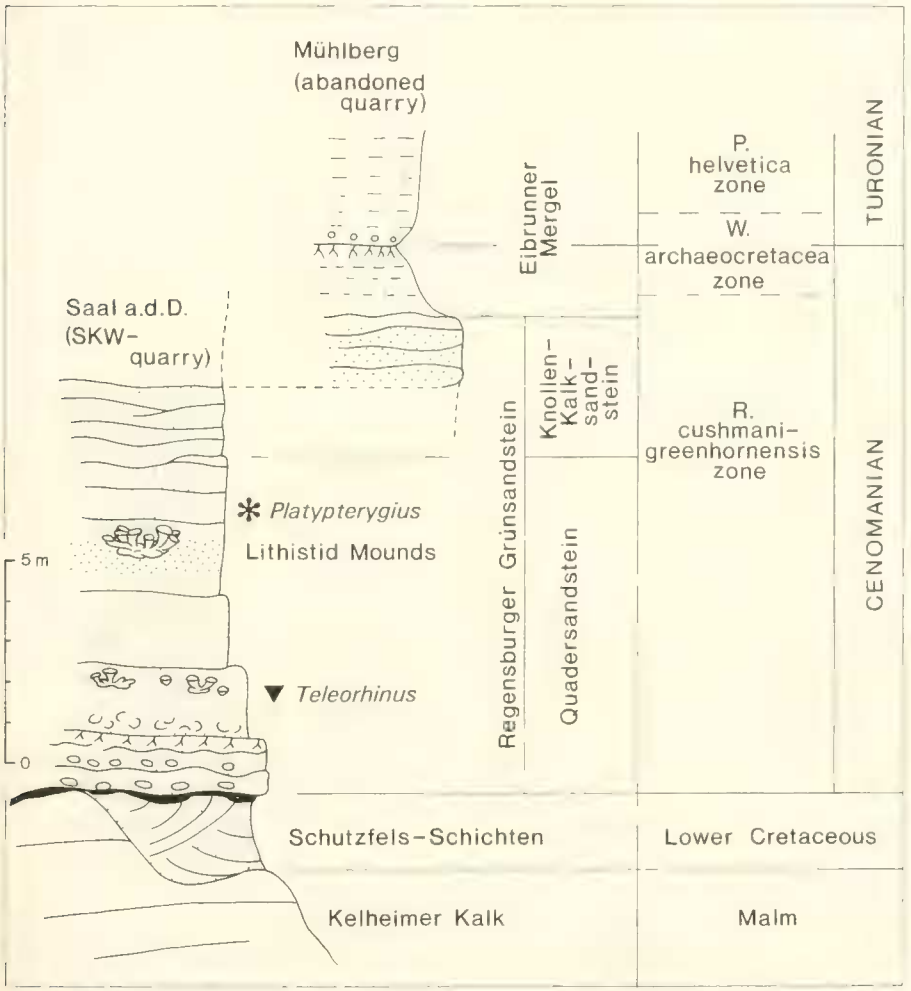

Fig. 2: Lithological section of the upper part of the SKW quarry at Saal a. d. D. with location of the ichthyosaur remains of *Platypterygius* (this paper) and of the crocodilian *Teleorhinus* (BUFFETAUT & WELLNHOFER, 1980). The section exposed in the Mühlberg quarry (7,5 km NE of Saal a. d. D.) is added showing its relative position to the sequence in the SKW quarry at Saal a. d. D..

mounds in a water depth of 20 to 40 m. The Regensburger Grünsandstein is a testimony of the great Albian-Cenomanian marine transgression of the Tethys from the South to the North and Northeast into the Regensburg Gulf (HERM, 1979). At the Mühlberg quarry the Cenomanian/Turonian boundary is 2,2 m above the top of the Regensburger Grünsandstein within the sequence of clays and marls of the Eibrunner Mergel (HERM & HOFLING, 1994). This boundary is recognized worldwide as a marked environmental change of marine life as consequence of a global ecological crisis (FORSTER et al., 1983), which could also have brought about the extinction of the ichthyosaurs (BARDET, 1994).

According to DACQUE (1939) the Regensburger Grünsandstein has yielded a diverse marine invertebrate fauna, but also a few marine vertebrate remains. Especially isolated teeth of fishes (*Oxyrhina, Otodus, Corax, Ptychodus, Anomoeodus, Protosphyraena*), of a pliosaur (*Polyptychodon*), and of a mosasaurid (*Liodon*) have been reported (MEYER, 1856; WAGNER, 1853). Also a jaw fragment of a pholidosaurid crocodilian, *Teleosaurus* cf. *browni*, has been described from the same quarry at Saal, but from a slightly lower horizon than the ichthyosaur remains (BUFFETAUT & WELLNHOFER, 1980). DACQUÉ (1939) also mentioned large jaw fragments with longitudinal grooves which he attributed to ichthyosaurs. However, this material, originally housed in the Bavarian State Collections, was lost during World War II.

Systematic Description

Ichthyopterygia
Temnodontosauridae GODEFROIT, 1994
Platypterygius v. HUENE, 1922

Platypterygius sp.
Plate 1

M a t e r i a l: Incomplete, fragmentary skeletal remains of a large ichthyosaur including parts of the skull (jugal and undetermined bones) and jaws, numerous teeth, vertebrae, ribs and phalanges. Most of the bones, except the teeth, are flattened because of post mortem diagenetic processes which caused compression and crushing. The material is housed in the Bayerische Staatssammlung für Paläontologie und historische Geologie, München, under the catalogue number BSP 1991 I 111.

S k u l l (Pl. 1, Fig. A): The only skull bone which could be indentified is the jugal. It lacks the proximal part of the ascending ramus. The jugal appears to be robust and is about 40 cm long. The horizontal ramus is divided into a laterally compressed anterior and a dorsoventrally flattened posterior part. The vertical ramus is laterally compressed.

Other fragmentary remains could possibly belong to the skull or jaws but are inadequate for description.

J a w s and t e e t h (Pl. 1, Figs. B, C): Upper and lower portions of the jaws are preserved in close contact (plate 1, figure C). The jaws are elongated and robust with a longitudinal groove on the lateral surface. The insertion of the teeth is of „aulacodont" type (MAZIN, 1983) which explains that several teeth were removed from the alveolar rows.

Numerous well preserved teeth of different sizes (2 to 5 cm high) have been collected (plate 1, figure B). They are globally stout and slightly curved. The crown occupies one fourth to one third of the total length and is rounded in cross section. The enamel is sculptured by several regularly spaced, longitudinal ridges. The upper part of the root is smooth and oval in cross

section, whereas the lower part is quadrangular in cross section and covered by rough longitudinal ridges. At the base there is an internal rounded replacement opening developed.

Vertebrae and ribs (Pl. 1, Figs. D, E, G): The vertebrae (plate 1, figures D, E), 8 to 10 cm in diameter, are mostly flattened (length: 2 cm). One vertebra imbedded in a block of matrix remained uncrushed and is 4 cm thick with deeply excavated biconcave articular surfaces. No neural arches are preserved. One vertebra bears two rib facets indicating a dorsal position within the vertebral column.

Numerous rib fragments are preserved (plate 1, figure G). They are very thick and flattened antero-posteriorly, compressed medially, resulting in an almost reniform cross section.

Limb bones (Pl. 1, Fig. F): Two phalanges are preserved being typical small flattened disks with a diameter of less than 2 cm.

Systematics

The relatively great size and robustness of the bones suggest an ichthyosaur of large size (about 8 to 10 m long). The bones which could be used for comparison (i. e. jugal, teeth, jaws) resemble, both in size and general morphology, those of specimens assigned to *Platypterygius* from the Albian of Normandy (Buffetaut, 1977), the Cenomanian of the Boulonnais (Bardet, 1989) and the Albian-Cenomanian of England (Owen, 1851). On the basis of the general proportions and robustness of the bones, the teeth divided into three distinct areas and the jugal morphology, the Bavarian ichthyosaur is here referred to as *Platypterygius* sp..

Implications

As mentioned above, „*Ichthyosaurus*" *campylodon* was originally established on the basis of material from the Chalk of England (Carter, 1846a, 1846b). Commonly, ichthyosaur remains from the Albian-Cenomanian of Western Europe have subsequently been referred to this species. Later, „*I.*" *campylodon* has been referred to *Myopterygius* (Huene, 1922), and finally to *Platypterygius* (Kuhn, 1946). However, it has remained a poorly defined species (McGowan, 1972). A review of the characters indicated by Carter (1846a) to define „*I.*" *campylodon* shows that they are not diagnostic because they are also present in other Cretaceous ichthyosaur species as well as in the Upper Jurassic genus *Grendelius* (Bardet, 1990). Thus, as already suggested by McGowan (1972) and despite the familiarity of the name, the type specimen of *P. campylodon* is rather poor and the species name must be regarded as nomen dubium (Bardet, 1990). Finally, further diagnostic material from the Albian-Cenomanian of Northern France is currently under study (Bardet, in prep.).

During the Cretaceous, ichthyosaurs are considered to have declined well before the Cenomanian, although several fragmentary remains have been reported from younger formations (Russel, 1977; Sullivan, 1987). Reports of presumed ichthyosaur fossils from the Campanian and Maastrichtian of North America (McGowan , 1973, 1978) have recently strengthened the classical view arguing that ichthyosaurs reached the end of the Cretaceous to fall victim to the K/T crisis (Russel, 1977). According to Sullivan (1987), the last occurrence of ichthyosaurs in the fossil record was probably in the Campanian. On the other hand, Baird (1984) has recently noted that the material described by McGowan (1973, 1978) is in fact plesiosaurian and has suggested that the occurrence of ichthyosaurs after the Cenomanian remains to be demonstrated.

Recently, a review of post-Cenomanian presumed ichthyosaur remains has shown that they are too poorly defined both systematically and stratigraphically in order to permit a valid

extension of the stratigraphical range of ichthyosaurs into post-Cenomanian times (BARDET, 1992). Thus, the youngest ichthyosaur specimens were previously known from the top of the Lower Cenomanian of Northern France (BARDET, 1989) and possibly from the Middle Cenomanian of England (BARDET, 1992). In this context, the specimen from the Upper Cenomanian of Bavaria, described in this paper, currently represents the youngest safely dated and identified ichthyosaur in the fossil record. It also supports the view of an ichthyosaur extinction during the Cenomanian-Turonian environmental perturbations (BARDET, 1994).

Acknowledgements

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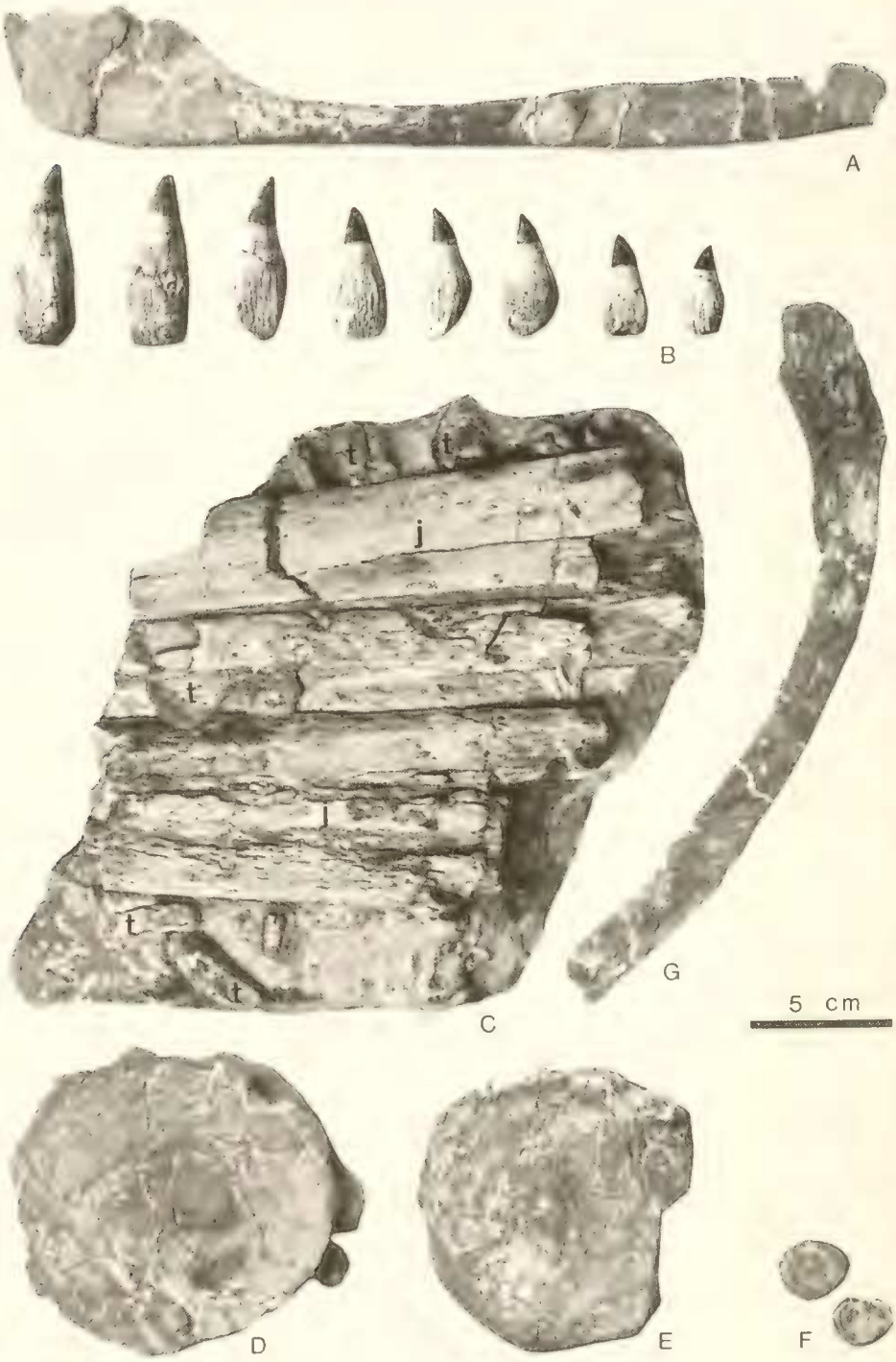
Plate 1

Platypterygius sp., Regensburger Grünsandstein, Upper Cenomanian, Saal a.d.Donau (Niederbayern). BSP 1991 I 111.

A. right jugal, lateral view; B. teeth; C. fragment of the jaws (j) with teeth (t); D-E. vertebrae; F. phalanges; G. rib.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